The Safe and Economical Treatment of Ballast Water

Outline

- Who are we?
- Chlorine Dioxide Background
- Bench-scale results
- Chlorine dioxide safety
- Ecopod™ System
- Path Forward

Who are we?

- Ecochlor: Specialty Chemical Experts
  - Industrial water treatment applications (pulp and paper, refining, chemical process)
  - Municipal water treatment applications (drinking water, waste water)
  - Employees and Consultants bring over 100 years of experience
- Seaworthy: Marine Engineering Experts
  - Providing Marine Engineering / Naval Architecture services for over 30 years

Chlorine Dioxide - Background

- Used in USA for over 50 years
  - Drinking water & waste water disinfection
  - Industrial process water disinfection
  - Food and vegetable treatment
- Completely effective on all organisms
  - Nothing immune to ClO_2
- Highly effective on biofilm
  - Penetrates and neutralizes slime coating
  - No re-inoculation
- Highly soluble in water
  - Dispersible throughout a water system

Chlorine Dioxide - Background

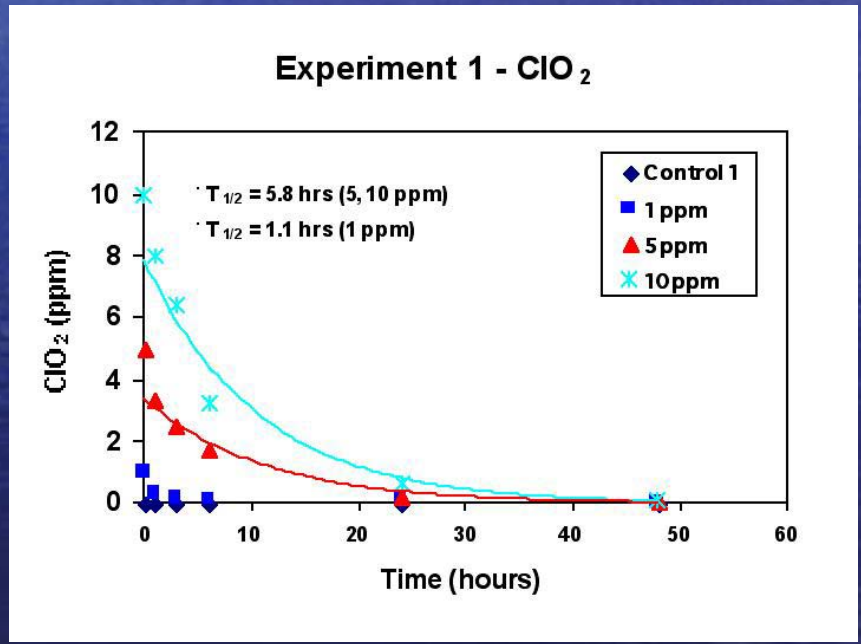
- Currently regulated in USA by EPA & FDA
  - Known technology
- Environmentally acceptable methodology
  - No residual discharged
  - No chlorinated compounds
  - No unwanted side reactions
- Does not effect base metals, coatings, pH
- Economically generated on site
  - Safely done in over 1,000 USA applications
  - Safely done on board ship

Bench-scale results:

University of Rhode Island Graduate School of Oceanography

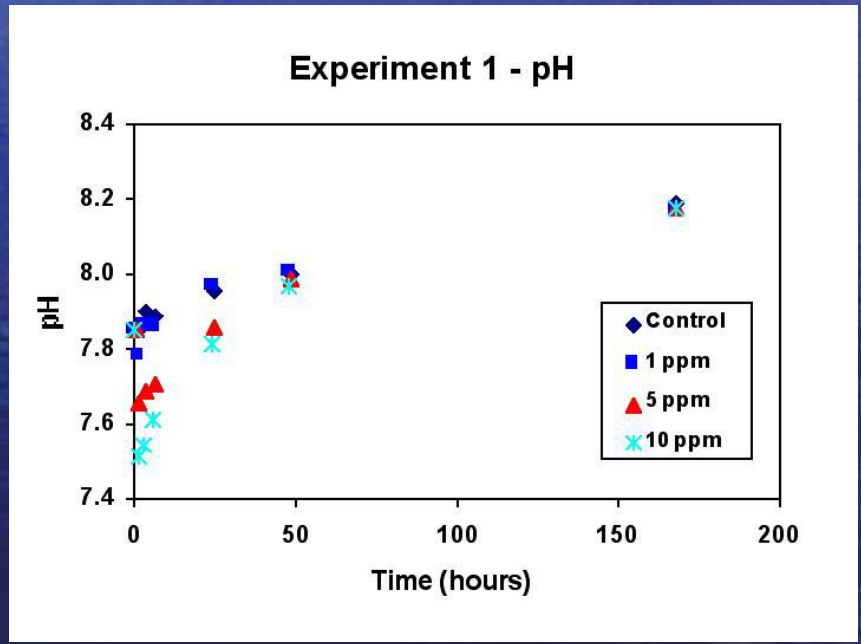
Chlorine dioxide residual

- Below detection limit in 24 ours at 5ppm
- Neutralize incoming ballast water
- Neutralize biofilm in ballast water system
- Discharge no residuals



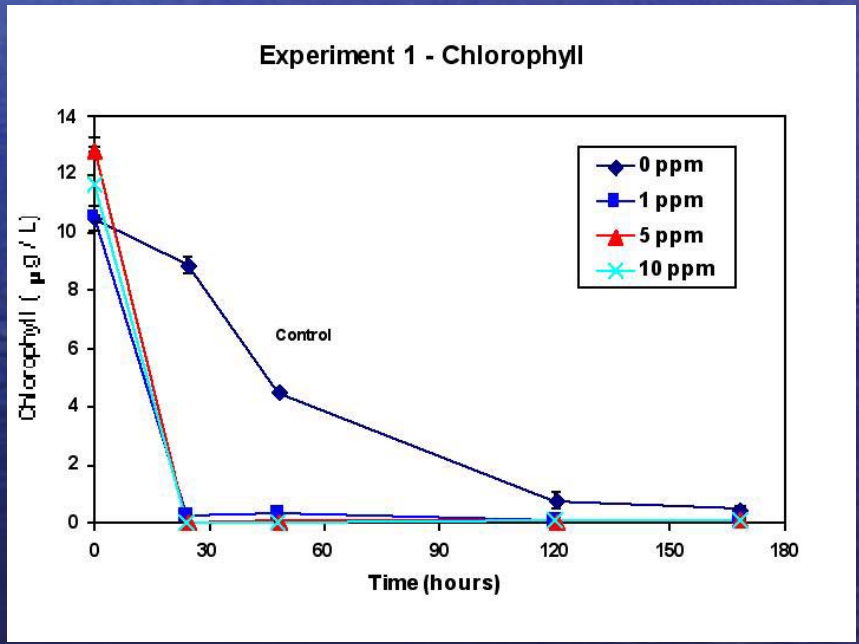
Effects on pH

- Sight drop ~0.1 pH units after dose
- No effect after 2 days through 7 days



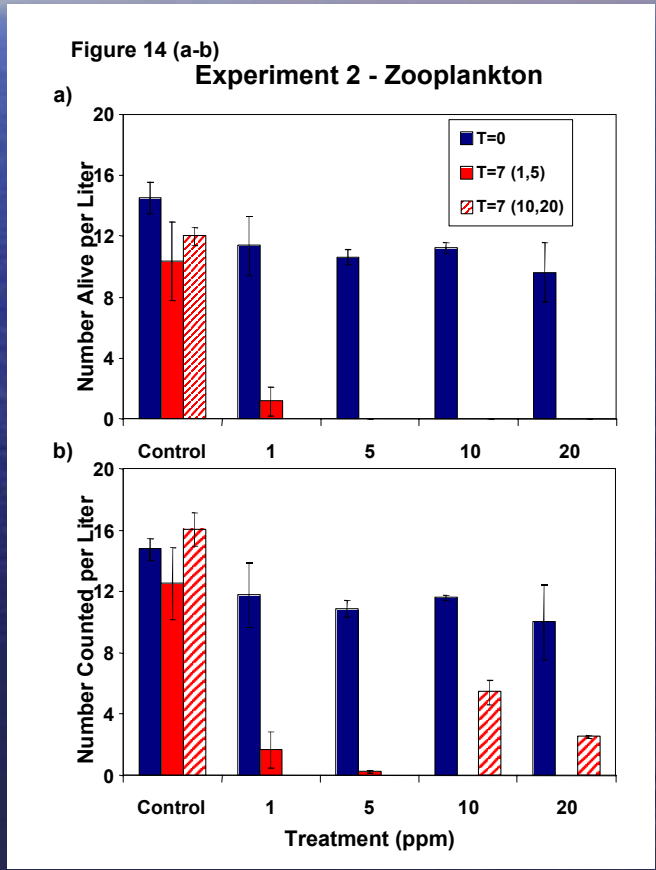
Phytoplankton

- Over 99.6% control in 24 hours at 5 ppm
- Over 99.7% control in 7 days at 5ppm
- Depletion in control due to lack of sunlight over 7 days



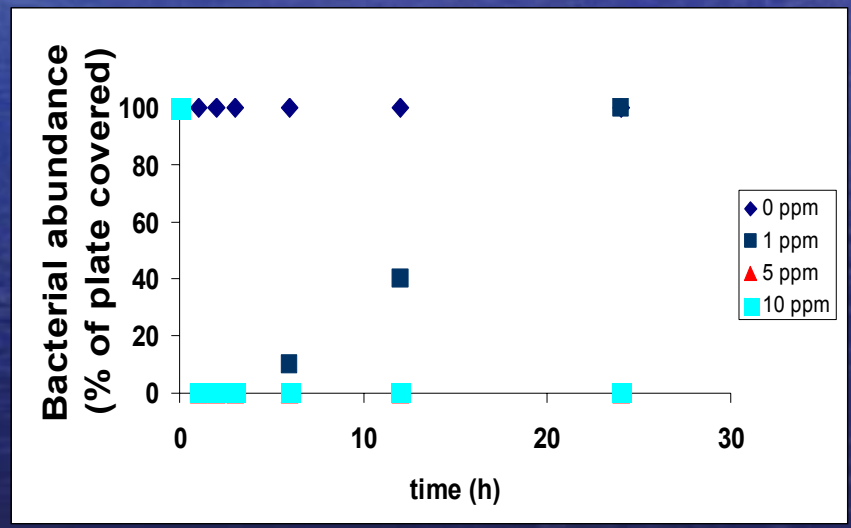
Zooplankton

- 98.4% control in 24 hours at 5 ppm
- 100% control in 7 days at 5 ppm



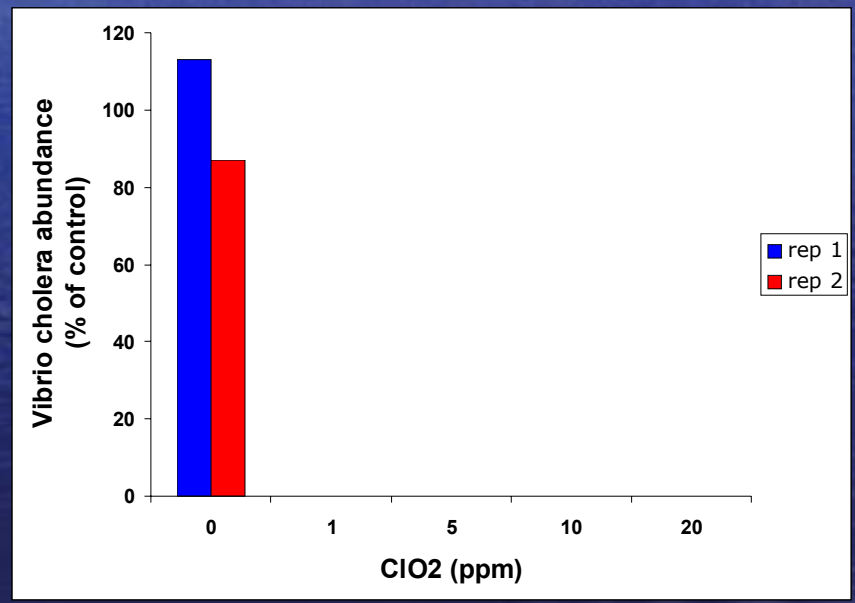
Bacterial control

- Re-growth seen at 1 ppm level
- 100% effective in 24 hours at 5ppm or above
- No re-growth at 5ppm up to 7 days



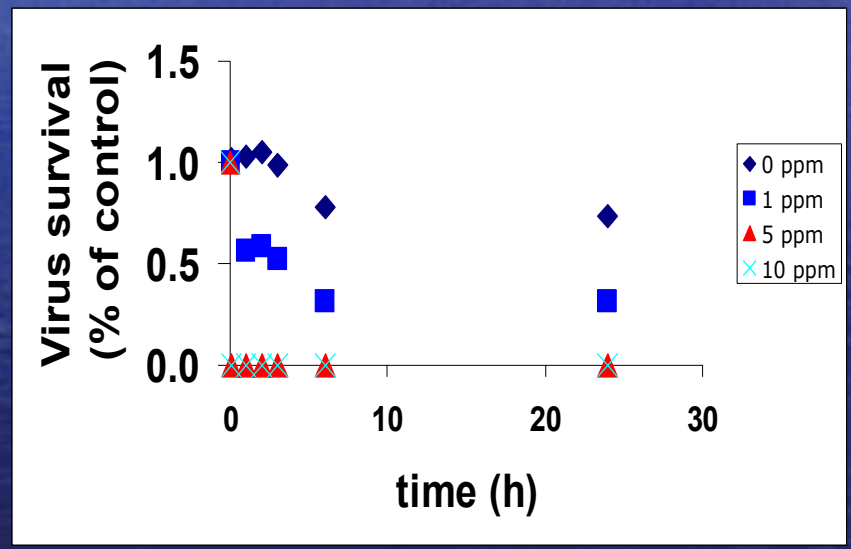
Vibrio cholera

- Complete control at all dosages within 24 hours



Virus

- 50% control at 1 ppm over 24 hours
- 100% control at 5 ppm in 2 hours
- No re-growth seen at 5 ppm at 7 days



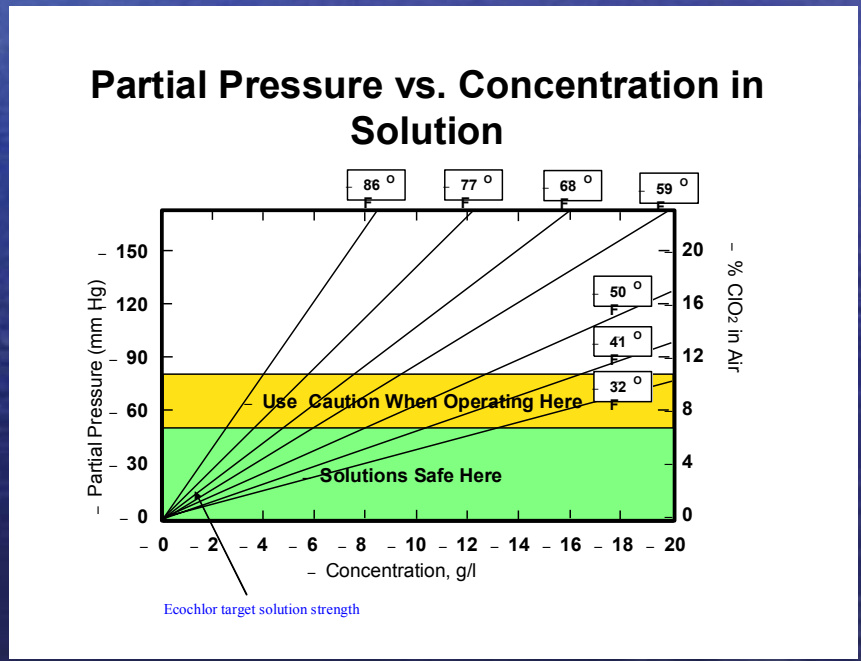
URI Data Summary

- Dosages of 5 ppm sufficient to neutralize all target organisms in 24 hours.
- Level of control satisfies current USA legislation (Washington State) and draft IMO standards.
- Residuals depleted in 24 hours.
- No re-growth seen in 7 days.

Safety

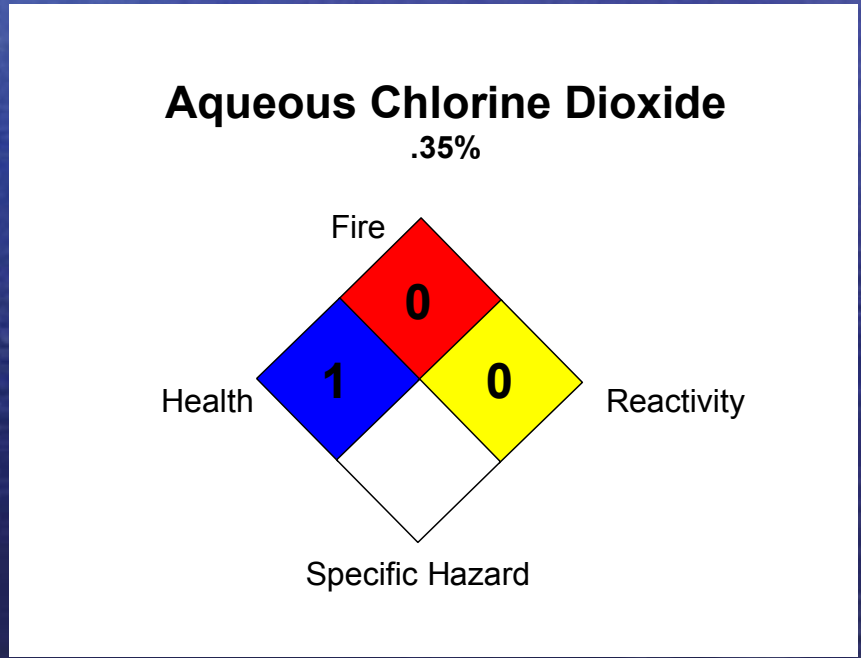
Chlorine dioxide solution

- Solution generated at safe concentrations (1,500 – 2000 ppm)
- Safe at all temperature ranges



Chlorine dioxide solution

- Hazardous labels for the dilute solution of chlorine dioxide (3,500 ppm)



Chlorine dioxide precursor chemicals

- Can be safely stored onboard ship
- Preplanning necessary to identify proper locations
- Follow common sense housekeeping practices

Chlorine dioxide at 5 ppm dosage

- No effect on base metals of ship.
- No effect on coatings.
- Minimal initial effect on pH, ~0.1 pH units.
- Dosage to neutralize incoming water and to neutralize biofilm in ballast water system.
- No residual at discharge. No chlorinated byproducts.

Environmental:
Discharge Data

Comparing Cl_2 and $Cl0_2$

- Different chemistries, different effects on organics, different effects on environment.
- Cl_2 is very reactive with organics; $Cl0_2$ is not.
- Cl_2 forms THM, TOX; $Cl0_2$ does not.
- Cl_2 much more toxic decomposition products than $Cl0_2$

LC_{50} for 48-hr continuous exposure TRO vs ClO_2^- (mg/L)

	TRO	ClO_2^-
• Rainbow trout	0.211	405.4
• Fathead minnow	0.261	123.2

LC_{50} for 96-hr intermittent exposure TRO vs ClO_2^- (mg/L)

	TRO	ClO_2^-
• Rainbow trout	0.297	947.9
• Fathead minnow	0.413	883.8

Treatment System: Ecopod™ Unit

Ecopod™ Unit

- Self-contained Unit
  - Standard 20’ shipping container or similar footprint
  - Chemicals, Generator / System Controls
  - Utilizing a patented and proven generation system
- Easy to Install
  - Deck mounted option or convenient container slot
  - Accomplished during normal ship operations
  - Power requirements: 20 KW
  - Water source; 25 – 50 gpm (ballast water slip stream)

Ecopod™ Unit

- Ecopod™ systems operational ranges of ballast water max flow:

  500 metric tons / hr *to* 7,500 metric tons / hr
  (2,200 gpm *to* 33,000 gpm)

- Fully Automated
  - During ballasting only
  - Controls generation and dosage, completely verifiable
  - No crew requirements

Ecopod™ Unit

- Cost estimates:

Contact Tom Perlich

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Birmingham, AL 35242

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Path Forward

Path Forward

- Secure Washington State Approval
  - Currently working with Dept. F&W
  - Currently working with Dept. Ecology
  - Ongoing dialog with EPA
  - Recognize need to involve community stakeholders
- Conduct Shipboard Demonstration
  - Treatment effectiveness
  - System runnability
- US Coast Guard
  - Continue dialog (Washington DC, R&D)
  - Obtain USCG approvals

First Shipboard Evaluation

- Ecochlor funds first installation and evaluation.
- Secure Washington State approval.
- Special pricing for ongoing relationship.
- Special pricing for additional units.

Summary

- Ecochlor treatment methodology will satisfy the most rigorous requirements.
- Ecochlor is working to secure Washington State approval.
- Seeking a ship owner interested in a approved, cost effective, reliable and crew friendly treatment option.

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